

# SWIRP: Compact Submm-Wave and LWIR Polarimeters for Cirrus Ice Properties

Completed Technology Project (2017 - 2019)



## Project Introduction

Clouds remain as a major source of uncertainty in climate models. Ice clouds, in particular, are poorly constrained and have been used as a tuning parameter in the models to balance radiation budget at the top of atmosphere and precipitation at the surface. Lack of accurate cloud ice and its microphysical property measurements has led to large uncertainty about global clouds and their processes within the atmosphere. NASA's Aerosol, Cloud and Ecosystems (ACE), an Earth Science Decadal Survey (DS) mission, recommended an advanced science payload with submm-wave and longwave infrared (LWIR) radiometers for such cloud ice measurement. In a recent community white paper, Cloud and Precipitation Process Measurements (CaPPM), dynamics and microphysical properties are identified as the key links between the cloud-precipitation processes and need more accurate measurements. In this project we will develop a compact Submm-Wave and LWIR Polarimeters (SWIRP) instrument to enable accurate measurements of cloud ice and its microphysical properties (particle size and shape). Radiometric and polarimetric measurements from the proposed submm (220 and 680 GHz) and IR (8.6, 11, and 12  $\mu\text{m}$ ) bands, providing the needed sensitivity over a full dynamic range of cloud ice, will be used jointly in cloud retrievals. The conical scanning configuration with SWIRP will preserve horizontal (H) and vertical (V) polarization information for bulk cloud particle shape retrievals while the SWIRP's matched submm and LWIR footprints will allow the joint retrieval of cloud particle size with these frequency bands. The compactness of SWIRP design enables cost-effective deployment of these radiometers-polarimeters on future large space-flight missions (e.g., ACE), or on small distributed flight systems for rapid update and frequent revisit sampling to study fast atmospheric processes. In IIP-16 we will substantiate the technical feasibility of miniaturizing mm/submm polarimetric direct-detection receivers, a novel multi-channel LWIR spectro-polarimeters, and a compact Bearing and Power Transfer Assembly (BAPTA) for conical scanning observations. We will build a prototype instrument with self-calibration in a volume of 20x20x40 cm, and complete laboratory environmental and rooftop tests at the end of project. The entry level for the proposed instrument is TRL=3, and it will reach TRL=5 within the 3-year period of performance.

## Anticipated Benefits

This project will enable NASA's Earth Decadal-Survey mission, ACE, to quantify global cloud ice and its role in radiation and cloud-precipitation processes. For the new Decadal Survey (2018-2028), understanding cloud-precipitation processes will be a high priority towards improve climate and weather models, and the prototype instrument from this project will offer new cloud observation capabilities for the community need.



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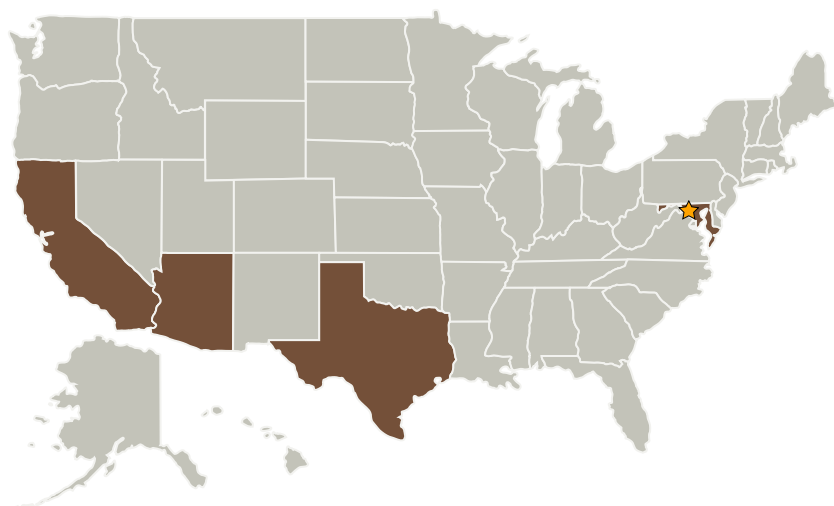
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Arizona	California
Maryland	Texas

## Organizational Responsibility

**Responsible Mission Directorate:**

Science Mission Directorate (SMD)

**Lead Center / Facility:**

Goddard Space Flight Center (GSFC)

**Responsible Program:**

Instrument Incubator

## Project Management

**Program Director:**

Pamela S Millar

**Program Manager:**

Parminder S Ghuman

**Principal Investigator:**

Dongliang Wu

**Co-Investigators:**

Negar Ehsan  
Russell Chipman  
William R Deal  
Ping Yang  
William B Gaines  
Jeffrey R Piepmeier  
David T Leisawitz  
Donald E Jennings  
Giovanni De Amici

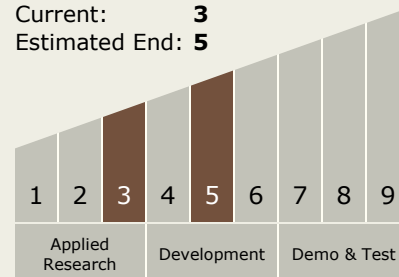
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## Technology Maturity (TRL)

Start: **3**  
Current: **3**  
Estimated End: **5**



## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

## Target Destination

Earth